As a rule, the warnings distributed were verified. A sharp rise in temperature occurred in extreme western Arizona on the morning of the 25th, however, that can not be accounted for satisfactorily.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT.

The weather in the San Francisco Forecast District during October, 1923, was largely controlled by slow moving HIGHS that entered the north coast of the United States from the Pacific Ocean. They drifted slowly eastward and apparently blocked the eastward movement of LOWS from the Aleutian Islands, which were very pronounced at sea during most of the month. One of the LOWS from the ocean moved inland on the 6th and joined forces with a LOW that apparently developed over the Southern Plateau States. The two combined caused light but general rains in this district.

The next LOW to enter the United States came by the way of British Columbia on the 16th and it caused good rains in Oregon, Washington, and Idaho, and a few showers in northern California. The strongest winds of the month attended this disturbance, when maximum velocities of 80, south, 60, southwest, and 46, south, occurred at Northhead, Tatoosh, and Seattle, respectively.

Another LOW from the Pacific Ocean entered British Columbia on the 21st. A small secondary also formed over California on the same day, and the two combined caused light but general rains in the northern half of the district and a few showers in Nevada and in extreme northern California.

On the last two days of the month a LOW appeared over the Southern Plateau States that caused light rains in the lower portion of California.

Storm warnings were issued on the 5th, 14th, 15th, and 16th. For the most part they were verified. Frost warnings were issued for portions of the north Pacific States on the 7th, 8th, 12th, 17th, 18th, 19th, and 23d. They also were verified, and as the season for vegetation at practically all places in that section closed during the month, warnings are now no longer needed in that section except near the coast.—*E. A. Beals.*

RIVERS AND FLOODS.

By H. C. FRANKENFIELD, Meteorologist.

Owing to the prolonged drought, all streams of the Middle and North Atlantic States were at very low stages during the greater portion of the month. Water supply for manufactories and domestic purposes almost reached the vanishing point in many localities, and many industrial plants were threatened with total suspension of operations. In some localities even drinking water had to be transported, and relief did not come until the heavy rains set in about October 23. These rains soon relieved the situation, and in the lower Connecticut River the rise assumed the proportions of a near flood. From 5 to 6 inches of rain fell over the valley below Holyoke, Mass., but without resulting flood stages in the river, owing to the extremely dry condition of the soil. Warnings of the coming of the rise were issued on October 25.

There were no floods east of the Mississippi River, but they were quite general in the western tributaries, particularly in both branches of the Canadian River and in the lower Arkansas. In the State of Oklahoma the floods were especially destructive.

Heavy rains set in during the last two days of September over the headwater areas of the Canadian River, the Texas Panhandle and extreme western Oklahoma, and extended eastward from October 1 to 3, inclusive, continuing at the same time to the westward. The heaviest rain reported was at Woodward, Okla., where 11.50 inches fell from September 29 to October 3, inclusive. Another rain period set in about October 11, with a three-day rain of 6.30 inches at Woodward. Even over the headwater districts on the eastern mountain slopes of New Mexico and in the Texas Panhandle the floods were severe, and warnings issued were well verified. The following report on the floods in the State of Oklahoma was prepared by Mr. J. P. Slaughter, meteorologist in charge of the Weather Bureau office at Oklahoma City, Okla.:

Heavy rains fell over the Texas Panhandle and western Oklahoma from October 1 to 3, and warnings were issued for Camargo, Union City, and Calvin on the Canadian River, and for Canton and Reno Junction on the 3d, and for Oklahoma City on the 5th. The water did not go as high on the Canadian River as was expected, but did reach the forecast stage at stations on the North Fork of the Canadian.

Moderate to heavy rains were general again over the two drainage basins on October 6–7, and warnings were issued for Camargo, Union City, and Calvin on the Canadian, and for Oklahoma City on North Fork of Canadian on the 6th. Again the water did not rise as high as was forecast on the Canadian, but did reach the expected stage at Oklahoma City. Neither of these floods was serious, only the very low bottom lands being inundated, and no serious losses resulted.

Excessive rains occurred over the Texas Panhandle, western, central, and northern Oklahoma, October 11 to 16, resulting in high water in the Cimarron, Arkansas, Canadian, and Red Rivers, and disastrous floods in the North Fork of the Canadian and in the Washita Rivers. On the 11th, warnings were issued for Camargo and Union City on the Canadian, and for Oklahoma City on the North Fork of the Canadian. On the 12th, warnings were issued for Canton and Reno Junction on North Fork of the Canadian; and on the 13th, for Calvin on the Canadian, and for Reno Junction and Oklahoma City on the North Fork of the Canadian, a higher stage being fixed at the last named two places. On the morning of the 15th a warning of 20 feet or higher was issued for Oklahoma City. The water was only moderately high, close to or a little above flood stage on the Canadian River, and no serious damage resulted.

The flood in the valley of the North Fork of the Canadian was the greatest and most destructive in the memory of the oldest settlers. The river rose very rapidly in northwestern Oklahoma during the 11th and 12th, reaching a stage of 9.2 feet at Woodward about 6 p. m. on the 12th. This was 0.9 foot higher than the previous high watermark, 8.3 feet, on June 10, 1923. The flood waters advanced down the valley with much greater speed than usual, continuous rains swelling the flood as it advanced. The crest stages at river stations were as follows: Woodward, 9.2 feet on the 12th; Canton, about 13 feet on the 13th; Reno Junction, about 18 feet during the night of the 14th–15th; Oklahoma City, 23.2 feet, about 7 a. m., the 16th. The previous high water stages at these stations were as follows: Woodward, 8.3 feet, June 10, 1923; Canton, 8.6 feet, June 11, 1923; Reno Junction, 14 feet, June 12, 1923; Oklahoma City, 16.3 feet, June 14, 1923.

Warnings were disseminated throughout the valley by means of long distance telephone, the State board of agriculture cooperating, by telegraph and by the daily press. Everybody in the valley had ample warning of the impending flood and that it would be the worst since the country was opened for settlement.

A systematic effort made by State, county, and city officials to determine the damage resulting from this flood fixes the total loss at not less than $15,000,000, divided as follows:

Railroad bridges, culverts, and tracks	$1,650,000
Industrial plants in Oklahoma City	175,000
Oklahoma City water works	1,500,000
Bridges and roads in nine counties	1,500,000
Destruction of crops	4,000,000
Houses and livestock, probably	500,000
Damage to land by erosion, deposit of sand, and increased flood hazard	3,000,000
Miscellaneous unlisted damage	2,675,000
Total	15,000,000

Approximately 600,000 acreas of rich farm lands were inundated during this flood, and a considerable portion of this years crops had not been gathered.

Some portions of nearly all towns and cities on the banks of the river were flooded, areas that had never before been flooded. Oklahoma City was the greatest sufferer in this respect. About 1 a. m. on the morning of October 15 a report was received from the river

observer at Reno Junction, stating that the approach to the Rock Island bridge on which the river gage was located had been washed out, that it was impossible to reach the gage, and that the estimated stage of the river was 18 feet. City officials were at once called on the telephone and advised that a stage of at least 20 and probably 22 feet, 4 to 6 feet higher than the June flood, was expected in Oklahoma City on the morning of the 16th; also, that if the water reservoir dam, about 7 miles above the city gave way, a still higher stage might be expected.

A systematic and orderly evacuation of the flood district was begun the next morning, the police department, fire department, National Guard, American Legion, and various civic organizations assisting in the work. Approximately 1,800 families, with their effects, were moved during the day and early evening. About 11 p. m., the 15th, the earth embankment on the west side of the reservoir lake began to give way, and probably 500 more families were hurriedly moved to higher ground. Four persons were drowned in Oklahoma City during the night of the 15th–16th, due to the fact that many people refused to move out of the flood district until driven out by higher water than had ever been experienced before.

It has been found impossible to estimate the money value of property saved by warnings of this flood. Livestock, harvested crops, and movable property of all kinds were carried to higher ground throughout the entire valley, as from one to five days warning was given. It is estimated that $75,000 to $100,000 in movable property was saved in Oklahoma City, and for the whole valley the figures will go into hundreds of thousands of dollars.

The bridge in Oklahoma City on which the river gage was installed was washed out by the flood and the gage lost. Only one bridge within the city limits escaped the flood, and the approaches to this bridge were washed out.

The flood in the valley of the Washita was not so great nor destructive as has been experienced in the past. However, bottom lands were flooded throughout the entire valley, and losses were heavy. Two persons were drowned near Chickasha, horsemen trying to ford a tributary creek of the Washita.

The floods in the Arkansas River and its tributaries other than the Canadian were not very severe, yet they called for the issue of flood warnings at nearly all points. There was an early flood in the lower Purgatoire River, and a stage of 5.6 feet, or 1.6 feet above the flood stage, was reached at Higbee, Colo., on October 5, the flood continuing from October 4 to October 10, inclusive. The rise, however, was not sufficient to seriously affect the Arkansas River, and no flood stages were experienced in this river west of Great Bend, Kans.

From Wichita, Kans., to Dardanelle, Ark., including the lower Neosho River, the crest stages quite closely approximated the flood stages, except at Fort Smith, Ark., where the crest stage of 25.6 feet on October 17 was 3.6 feet above the flood stage. There were no flood stages experienced east of Dardanelle, Ark.

Warnings of the floods were issued as early as needed, and the losses reported were only $18,000, mainly to crops, while the value of property saved through the warnings was given as $15,000.

Minor floods occurred during the early days of the month in the North Platte River of Nebraska, and the Big Blue River of Nebraska and Kansas. They had been forecast previously, and no damage was reported.

The Red River floods were not serious as to stages reached, and did not extend east of Fulton, Ark. They were caused by the same general rain conditions that caused the middle October floods in Oklahoma, but in much less intensive form. Warnings were issued well in advance of the floods, and they appear to have resulted in the saving of property valued at between $50,000 and $75,000. The losses as reported aggregated $55,000, almost entirely in crops.

With the exception of the Red, the Upper Trinity, and the Pecos Rivers, and the extreme lower Rio Grande, the rivers of Texas were comparatively quiet during the month. There was a local flood on October 17 and 18 in the Trinity River at Dallas, Tex., with the crest stage on October 18 of 23.5 feet, 1.5 feet below the flood stage. Warnings were issued on October 15 and 16.

The Pecos River was in flood beginning with October 3 in the upper river in New Mexico, and it was not until October 17 that the river at Pecos, Tex., fell below the flood stage of 11 feet. Warnings of this flood were also issued at the proper time. No damage was reported, and the effect of the flood waters upon the stages in the Rio Grande was negligible.

In the extreme lower Rio Grande the flood of late September continued until about October 7, additional heavy rains on October 5 bringing another crest of 22.1 feet at San Benito, Tex. This was 1.1 feet above the flood stage. Warnings for this flood were issued in September.

An unusual feature of the season was the rise in the Missouri River during the early days of the month. It doubtless came, via the Yellowstone River, from the Powder River flood of September, 1923, and was remarkable in that the stages in the Missouri River from Williston, N. Dak., to St. Joseph, Mo., were the highest recorded stages for the autumn season of the year. There were, of course, no floods, but the crest stages were many feet above the average stages for the time of year. It is interesting to follow the crest down the river from Williston, and its progress as far as Cairo, Ill., is shown in the table below. While passing Yankton, S. Dak., it took away the pontoon bridge, causing a loss of $3,000. Below Cairo, Ill., only faint traces of the wave were visible.

Station.	Crest (feet).	Date.	Time to next station below (days).
Williston, N. Dak.	13.3	Oct. 4	
Bismarck, N. Dak.	8.0	Oct. 5	1
Pierre, S. Dak.	9.0	Oct. 7	2
Yankton, S. Dak.	7.2	Oct. 9	2
Sioux City, Iowa.	11.6	Oct. 9	0
Omaha, Nebr.	14.4	Oct. 11	2
St. Joseph, Mo.	8.8	Oct. 12	1
Kansas City, Mo.	16.9	Oct. 12	0
Hermann, Mo.	13.2	Oct. 14–15	2
St. Charles, Mo.	18.8	Oct. 15	1
St. Louis, Mo.	11.9	Oct. 15	0
Chester, Ill.	12.7	Oct. 16	1
Cairo, Ill. (mouth of Ohio River)	15.0	Oct. 18	2
Total time of travel			14

River and station.	Flood stage.	Above flood stages—dates. From—	To—	Crest. Stage.	Date.
MISSISSIPPI DRAINAGE.					
Arkansas:	*Feet.*			*Feet.*	
Great Bend, Kans.	5	12	13	6.2	12
Wichita, Kans.	9	13	14	9.9	13
Arkansas City, Ark.	15	14	15	15.6	15
Webbers Falls, Okla.	23	17	17	23.5	17
Fort Smith, Ark.	22	16	20	25.6	17
Dardanelle, Ark.	20	18	20	21.8	18–19
Purgatoire: Higbee, Colo.	4	4	10	5.6	5
Little Arkansas: Sedgwick, Kans.	18	12	12	19.2	12
Neosho: Fort Gibson, Okla.	22	17	17	23.0	17
North Canadian:					
Woodward, Okla.	3	(1)	9	[2]5.7	4
		11	16	9.2	12
Canton, Okla.	4	4	5	[2]4.6	5
		13	15	13.0	13
Reno Junction, Okla.	12	15	16	18.0	15
Oklahoma City, Okla.	12	6	11	13.8	8
		13	19	23.2	16
Canadian:					
Logan, N. Mex.	5	3	6	14.0	6
		9	11	12.5	9
Canadian, Tex.	5	3	3	8.0	3
		5	5	9.0	5
		7	7	8.0	7
		11	12	{Above 9.0}	12
Red River: Arthur City, Tex.	27	18	18	28.2	18
North Platte: North Platte, Nebr.	5	3	4	6.0	3
Big Blue: Beatrice, Nebr.	16	2	3	20.0	2
RIO GRANDE DRAINAGE.					
Rio Grande: San Benito, Tex.	21	[1]1	7	22.1	6
Pecos:					
Fort Sumner, N. Mex.	7	3	5	12.0	4
Pecos, Tex.	11	12	17	14.4	16

[1] Continued from October. [2] Estimated.